Geophysical Data Report

ATMOSPHERIC RADIO NOISE DATA BANGKOK, THAILAND—March-May 1967

By: RANGSIT CHINDAHPORN LT. CHAIKAMOL LUMJIAK
PRAJUAB NIMITYONGSKUL

Prepared for.

U.S. ARMY ELECTRONICS COMMAND
FORT MONMOUTH, NEW JERSEY 07703

CONTRACT DA-36-039 AMC-00040(E)
ORDER NO. 5384-PM-63-91

Sponsored by
ADVANCED RESEARCH PROJECTS AGENCY
ARPA ORDER 371
FOR THE
THAI-U.S. MILITARY RESEARCH AND DEVELOPMENT CENTER
SUPREME COMMAND HEADQUARTERS
BANGKOK, THAILAND

STANFORD RESEARCH INSTITUTE
MENLO PARK, CALIFORNIA

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SRI Project 4240

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I INTRODUCTION

Measurements of atmospheric radio noise are being made by the Electronics Laboratory of the Military Research and Development Center (MRDC-EL), a joint Thailand-United States-organization in Bangkok., The noise-measuring equipment (Fig. 1), modeled after the U.S. National Bureau of Standards Radio Noise Recorder, Model ARN-2, is located near the village of Laem Chabang (Fig. 2), about 90 kilometers southeast of Bangkok, in order to minimize interference from man-made noise. A view of the site, showing the standard ARN-2 antenna and ground plane, is presented in Fig. 3.

The cooperation and participation of the staff members of the Thailand Ministry of Defense and the support of the United States Advanced Research Projects Agency and the U.S. Army Electronics Command, have made it possible for the data presented in this report to be accumulated.

Tables I and II, below, present information about the site and the equipment.

For convenience in applying the results in this study, a nomogram for transforming effective antenna noise figure to noise field strength as a function of frequency is presented in Fig. 4.

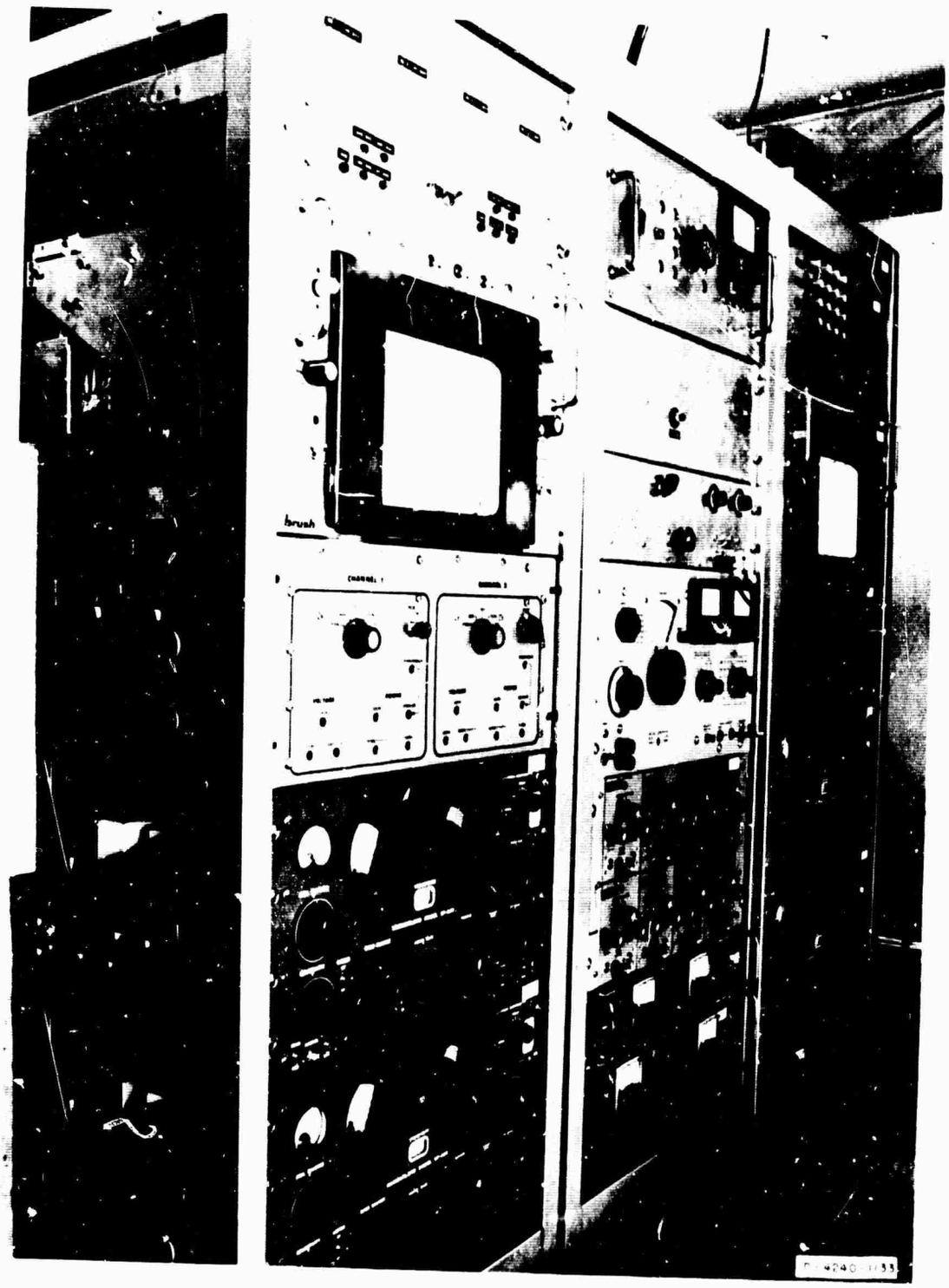


FIG. 1 ARN-3 ATMOSPHERIC RADIO NOISE MEASURING EQUIPMENT

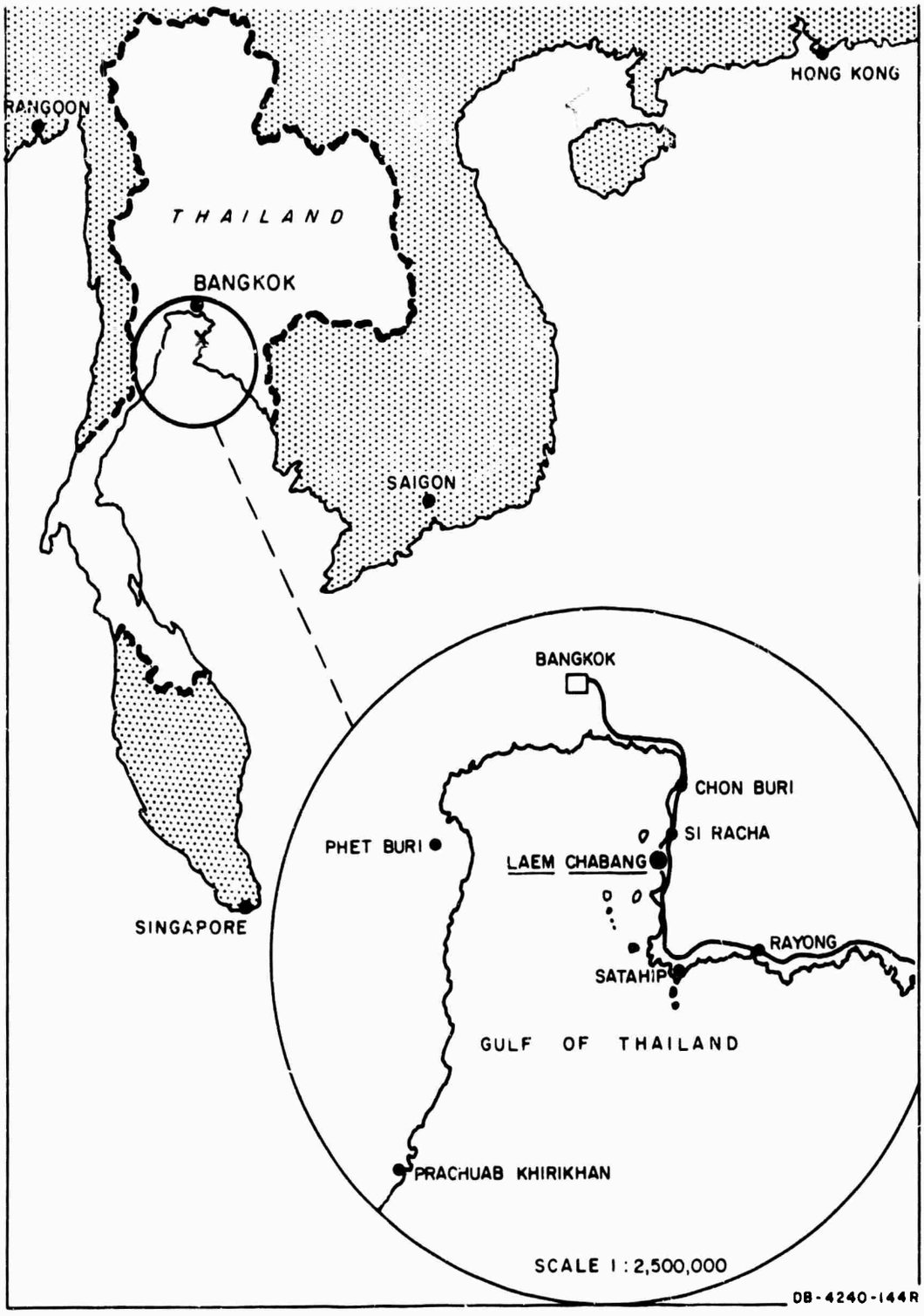


FIG. 2 LOCATION OF THE RADIO NOISE RECORDING STATION AT LAEM CHABANG, THAILAND

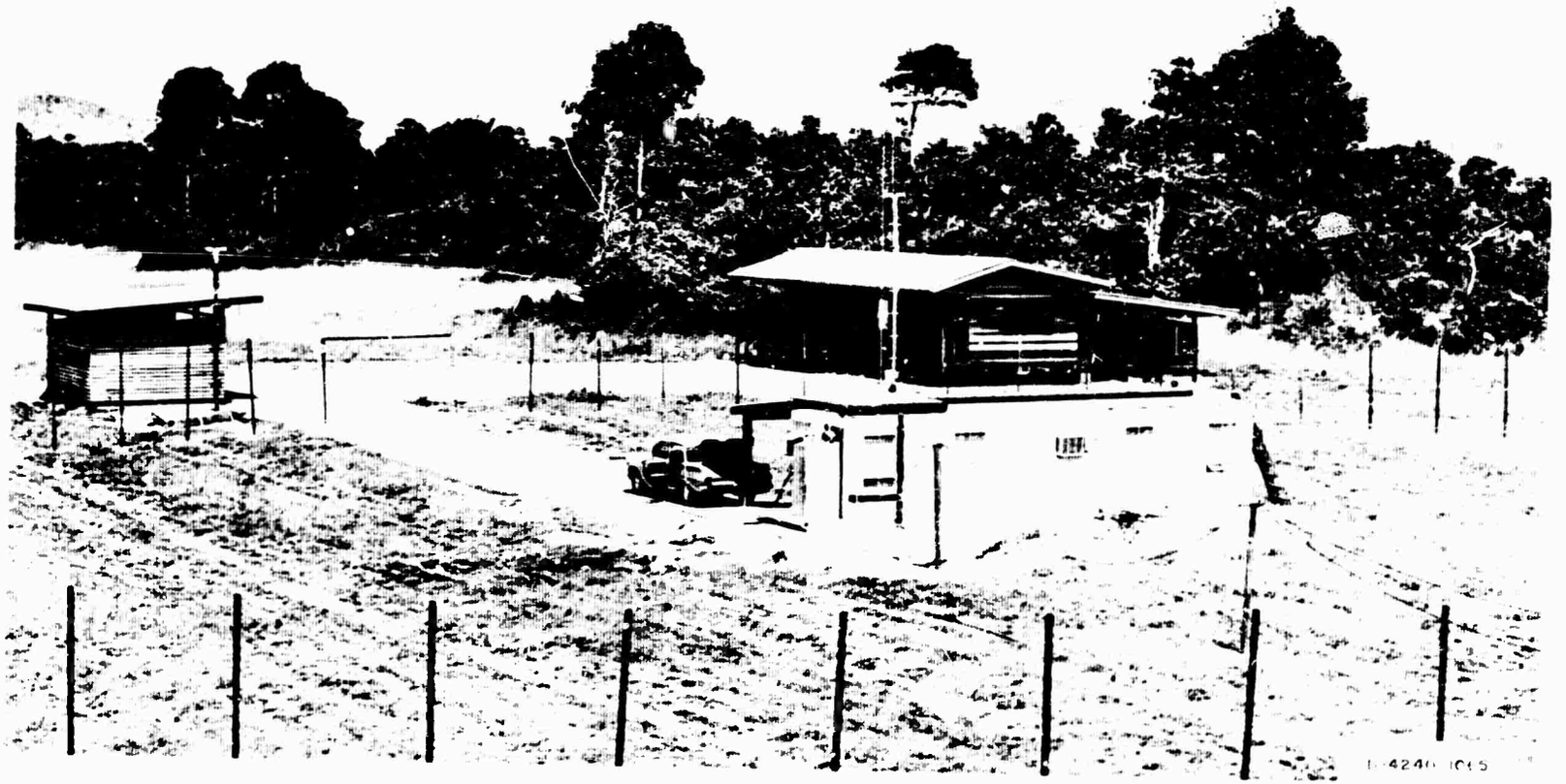


FIG. 3 RADIO NOISE RECORDING STATION

Table I

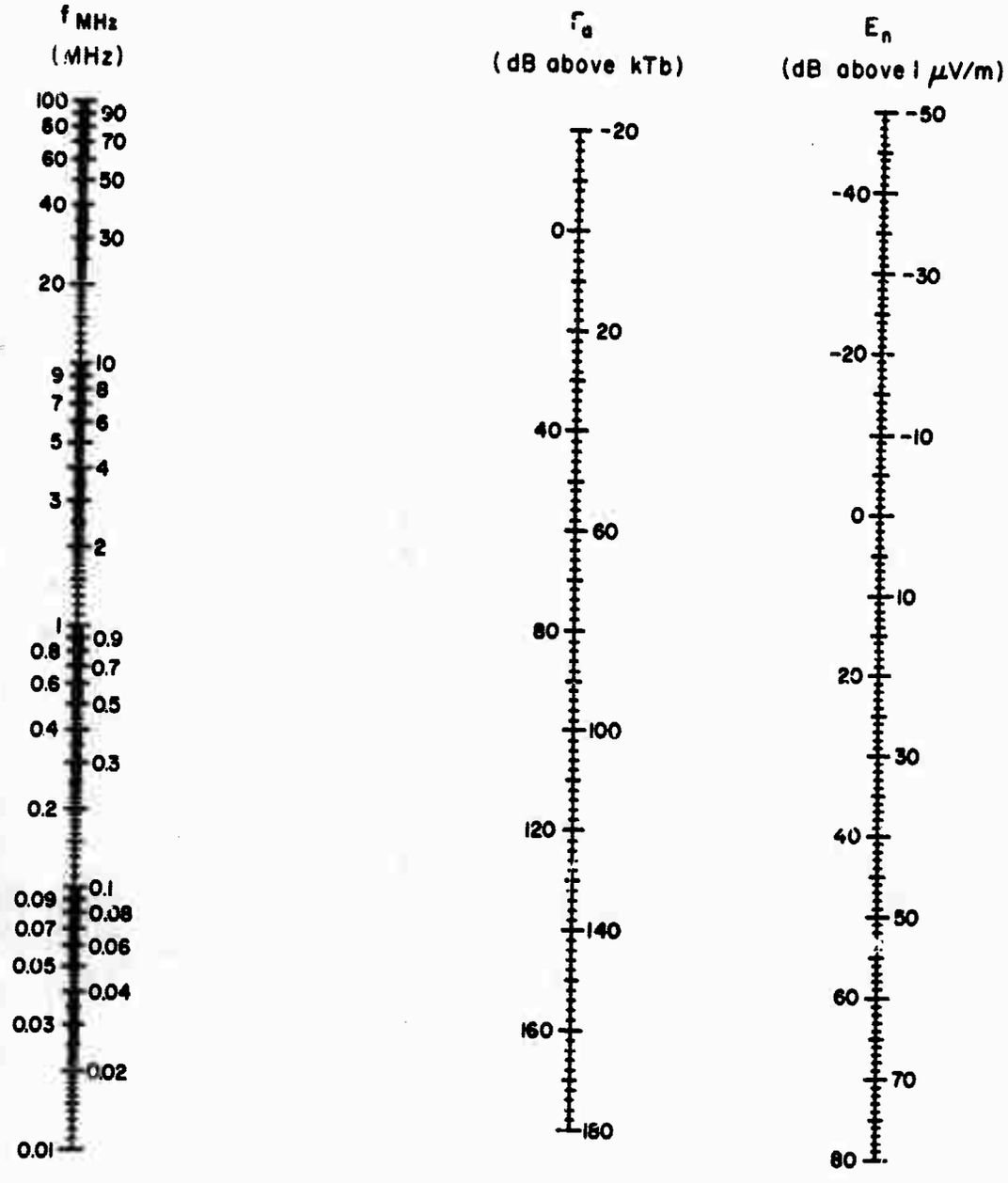
RADIO NOISE MEASURING SITE AT
LAEM CHABANG, THAILAND

GEOGRAPHIC LOCATION		ELEVAT ν ANGLE OF HORIZON
Latitude	Longitude	
13.55°N	100.90°E	Less than 3 degrees in all directions; zero degrees towards the west (Gulf of Thailand)

Table II

ARN-3 RADIO NOISE RECORDER SPECIFICATIONS

Antenna	Standard 6.6294-meter (21.75 feet) vertical antenna with ground plane consisting of ninety radial wires, each approximately 100 feet long.
Frequencies of Measurement	6, 13, 27, 160, 530, 2,300, 5,000, and 10,000 kHz.
Effective noise bandwidth of receiver	200 Hz
Recording chart speed	5 cm per hour



$$E_n = F_a + 20 \log_{10} f_{MHz} - 65.5$$

DB-4240-261

F_a = Effective Antenna Noise Figure = External Noise Power Available from an Equivalent Short, Lossless, Vertical Antenna in dB Above kTb.

E_n = Equivalent Vertically Polarized Ground Wave rms. Noise Field Strength in dB Above 1 μV/meter for a 1-kHz Bandwidth.

f_{MHz} = Frequency in MHz

Source: ESSA Tech. Report IER 18-ITSA 18-28

FIG. 4 NOMOGRAM FOR TRANSFORMING EFFECTIVE ANTENNA NOISE FIGURE TO NOISE FIELD STRENGTH AS A FUNCTION OF FREQUENCY

II DISCUSSION

The noise data contained in this report are compatible with the data in a series of Technical Notes published by ITSA,* (Series 18) "Quarterly Radio Noise Data." The following two parameters of the atmospheric noise are tabulated in the Appendix:

(1) Mean power

(2) Mean envelope voltage.

The mean power is a basic parameter and is expressed as an effective antenna noise factor, F_a. F_a is defined as the noise power available from an equivalent loss-free antenna in dB above kTb, the thermal noise power available from a passive resistance, where

k = Boltzmann's constant (1.38×10^{-23} joules per degree Kelvin)

b = Effective receiver noise bandwidth (Hz)

T = Reference temperature, taken as 288°Kelvin.

The mean envelope voltage, V_d, is expressed as a deviation in dB below the mean power.

Four frequencies, either in the MF and HF bands or in the VLF and LF bands, may be recorded simultaneously for 30 minutes. Switching between the two sets of four frequencies is accomplished automatically each half hour. The average power and the mean envelope voltage are recorded on an 8-channel strip-chart recorder. The thirty-minute samples are taken as representing the noise condition for the full hour.

The month-hour medians for power and voltage, F_{am} and V_{dm}, respectively, are determined from the hourly values scaled from the chart recordings for each of the corresponding frequencies. Normally, from twenty-five to thirty observations of the mean power are obtained monthly

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*Institute for Telecommunication Sciences and Aeronomy, of the Institutes for Environmental Research, Environmental Science Services Administration, U.S. Department of Commerce.

for each hour of the day and from ten to fifteen observations of the voltage deviations. When there are fewer than fifteen observations of the mean power or seven observations of the voltage deviations, the tabulated values in the Appendix are identified by an asterisk.

The extent of the variation of the noise power from day to day at a particular hour of the day can be determined from the upper and lower decile values of F_a. These are expressed in dB above and below the month-hour median, F_{am}, and designated by D_u and D_l, respectively, in Table A-1.

Time-block median values of noise are tabulated on a seasonal basis and are obtained by averaging all month-hour medians for the four hours of the day within the three-month period (see Table A-2 and Fig. A-1). The time-block values conform to the seasonal time-block values used in CCIR Report No. 322.

The results of the noise measurements at MF and HF for the months March, April, and May 1966, are given in this report. No data for LF and VLF for these months are available, but it is expected that data for these frequency bands will be published in subsequent reports.

APPENDIX

RADIO NOISE VALUES

Table A-1

MONTH-HOUR VALUES OF RADIO NOISE

Station: LAEM-CHABANG Lat. 13.05°N Long. 100.9°E Month March 1967

HR. (LT)	FREQUENCY (MHz)															
	0.53				2.3				5.0				10.0			
	F_{am}	D_u	D_l	V_{dm}	F_{am}	D_u	D_l	V_{dm}	F_{am}	D_u	D_l	V_{dm}	F_{am}	D_u	D_l	V_{dm}
00	99	4	11	2.5	76	9	7	2.0	60	10	10	1.0	47	10	5	1.0
01	98	6	12	3.0	75	12	11	2.5	62	10	9	1.0	47	9	5	2.0
02	97	7	13	4.0	76	12	13	3.0	61	9	8	2.0	46	8	7	1.0
03	97	7	13	4.0	75	11	9	4.0	60	10	9	1.5	44	11	5	1.5
04	97	6	16	4.0	74	12	11	4.0	59	7	9	2.0	44	15	8	1.5
05	95	6	11	4.5	73	13	9	4.0	61	7	14	2.0	47	14	10	0.5
06	90	6	5	2.0	73	14	12	2.0	*59	--	--	2.0	51	11	11	1.0
07	82	10	10	2.0	66	9	12	2.0	48	7	5	2.0	44	7	13	1.0
08	78	13	9	3.0	54	5	7	2.0	43	9	5	3.0	37	8	9	2.0
09	76	9	11	4.0	51	10	8	2.5	42	6	5	2.5	34	10	4	2.0
10	75	14	10	3.0	52	10	9	3.0	41	7	5	2.5	*34	--	--	1.5
11	*86	--	--	2.0	55	7	8	2.0	43	4	7	3.0	*35	--	--	1.0
12	*86	--	--	2.0	58	5	10	2.0	42	8	5	2.0	34	7	4	2.0
13	*76	--	--	2.5	57	5	8	2.0	42	11	4	2.0	36	7	9	2.0
14	81	13	16	5.0	57	9	9	3.0	43	12	5	2.5	36	6	5	2.5
15	87	8	23	5.5	61	11	11	1.5	46	11	8	2.0	41	5	7	3.0
16	92	9	16	5.0	67	17	10	1.0	51	9	8	1.0	47	8	10	3.0
17	93	15	10	3.0	75	10	12	1.5	61	8	9	1.0	50	15	7	2.0
18	97	4	9	2.0	79	5	11	1.5	67	12	11	0.5	59	6	16	2.0
19	99	4	11	3.0	77	11	10	2.0	69	10	11	0.5	55	9	10	1.5
20	98	6	10	3.0	77	11	8	2.0	72	6	14	1.0	57	10	11	1.0
21	100	5	11	2.0	77	12	6	2.0	71	10	11	1.0	59	10	10	1.0
22	100	4	9	2.5	79	9	9	2.0	70	7	11	1.0	57	10	12	0.5
23	100	4	11	3.0	75	10	7	2.0	65	9	11	1.0	50	11	6	1.0

* = Less than 15 days/month for F_a or less than 7 days/month for V_d

F_{am} = Median value of effective antenna noise in dB above ktb

D_u = Ratio of upper decile to median in dB

D_l = Ratio of median to lower decile in dB

V_{dm} = Median deviation of average voltage in dB below mean power

Table A-1 (Continued)

MONTH-HOUR VALUES OF RADIO NOISE

Station: LAEM-CHABANG Lat. 13.05°N Long. 100.9°E Month April 1967

HR. (LT)	FREQUENCY (MHz)															
	3.53				2.3				5.0				10.0			
	F_{am}	D_u	D_l	V_{dm}	F_{am}	D_u	D_l	V_{dm}	F_{am}	D_u	D_l	V_{dm}	F_{am}	D_u	D_l	V_{dm}
00	99	7	7	3.0	76	6	3	3.0	66	12	9	1.0	60	6	5	2.0
01	99	9	10	4.0	76	7	3	3.0	65	13	9	1.0	62	5	3	9.5
02	100	7	12	4.0	76	4	5	4.0	66	14	14	1.0	57	7	9	9.5
03	99	9	8	4.0	75	16	5	4.0	66	10	10	1.0	59	8	10	10.0
04	100	7	9	5.0	74	12	6	5.0	66	9	11	1.5	61	10	7	5.0
05	97	13	11	5.0	74	8	6	4.5	68	9	10	1.0	64	5	6	6.0
06	90	22	8	3.0	69	17	4	5.0	58	16	5	2.5	62	4	7	2.0
07	86	17	8	6.0	70	18	7	6.0	52	6	6	3.0	50	4	8	7.0
08	90	15	16	6.0	65	9	10	6.0	47	9	3	3.5	42	9	6	9.0
09	84	20	10	8.0	65	12	8	6.0	47	11	5	3.0	39	9	6	9.5
10	88	25	14	8.0	64	13	12	6.0	47	10	5	2.5	38	7	7	7.5
11	105	12	25	4.0	66	21	14	5.0	49	20	7	4.0	39	14	7	9.0
12	107	12	28	7.5	72	17	19	7.0	51	10	9	4.0	41	13	8	7.0
13	107	12	24	7.0	76	12	22	6.5	54	11	9	4.0	39	14	4	7.0
14	107	11	25	6.0	78	12	22	5.5	57	7	14	4.0	47	9	9	9.0
15	110	6	19	5.0	79	12	17	5.0	57	6	10	3.5	48	10	7	8.5
16	105	9	19	5.0	77	9	12	4.0	58	6	6	2.5	53	6	8	3.0
17	104	7	10	4.0	80	5	7	3.0	64	9	5	1.0	61	6	7	4.0
18	104	6	13	3.0	81	6	9	2.5	71	6	7	0.5	66	6	5	3.0
19	104	5	10	4.0	81	3	8	2.5	71	4	4	0.5	65	5	4	5.0
20	104	5	11	3.0	80	6	4	2.0	73	3	5	0.5	69	3	5	3.0
21	104	3	11	3.0	80	6	4	2.5	73	9	6	0.5	68	5	3	2.0
22	103	5	7	3.0	79	7	4	3.0	69	10	4	0.5	68	3	5	9.0
23	101	7	9	3.0	77	5	6	3.0	64	14	6	1.0	63	5	6	2.5

F_{am} = Median value of effective antenna noise in dB above ktb

D_u = Ratio of upper decile to median in dB

D_l = Ratio of median to lower decile in dB

V_{dm} = Median deviation of average voltage in dB below mean power

Table A-1 (Concluded)

MONTH-HOUR VALUES OF RADIO NOISE

Station: LAEM-CHABANG Lat. 13.05°N Long. 100.9°F Month May 1967

HR. (LT)	FREQUENCY (MHz)															
	0.53				2.3				5.0				10.0			
	F_{am}	D_u	D_l	V_{dm}	F_{am}	D_u	D_l	V_{dm}	F_{am}	D_u	D_l	V_{dm}	F_{am}	D_u	D_l	V_{dm}
00	104	7	12	3.0	78	8	3	2.5	63	8	3	2.0	59	11	7	9.0
01	104	8	13	4.0	78	5	4	3.0	63	9	3	2.0	60	7	9	9.0
02	102	8	11	4.0	78	8	6	3.0	63	10	3	3.0	59	13	5	8.5
03	101	9	10	4.0	76	9	4	3.0	61	12	3	2.0	*60	--	--	9.0
04	100	10	13	4.0	78	5	6	4.0	62	6	7	2.5	58	7	5	10.0
05	93	16	11	3.5	77	5	7	3.0	62	8	6	2.0	64	6	7	9.0
06	91	21	11	2.0	73	9	7	2.5	59	7	7	2.0	61	8	8	10.0
07	90	21	15	2.0	70	13	5	3.0	57	11	5	3.0	51	14	7	10.0
08	90	17	15	3.0	71	6	8	3.0	51	8	4	3.0	45	8	8	10.0
09	87	22	10	7.0	69	9	5	3.0	49	8	4	3.0	41	10	12	10.0
10	88	13	17	6.0	69	5	5	3.0	49	8	5	3.0	41	11	8	9.0
11	90	17	13	5.0	69	8	7	2.5	51	8	6	3.5	39	10	7	9.0
12	92	17	14	6.0	70	10	6	2.5	51	9	6	4.0	41	8	7	9.0
13	99	13	12	8.0	71	7	5	4.0	51	10	8	4.0	43	8	8	9.0
14	102	13	16	8.0	74	12	8	4.0	53	9	4	4.0	43	6	5	8.0
15	104	7	16	8.0	72	11	3	4.0	56	8	7	3.0	47	9	7	8.0
16	104	9	13	6.5	75	8	8	3.5	59	5	6	3.0	52	7	8	8.0
17	102	9	11	6.0	78	7	6	2.0	62	2	4	2.0	63	5	12	8.0
18	101	9	8	4.0	79	5	5	2.0	68	2	5	1.0	67	4	6	8.0
19	101	8	8	4.0	79	7	3	2.0	71	3	7	1.5	66	5	5	8.0
20	102	6	9	3.5	80	5	4	2.0	70	3	5	1.5	67	4	5	8.0
21	103	6	9	3.5	81	4	5	2.0	70	4	5	1.5	67	5	5	8.5
22	103	6	10	3.0	80	4	4	2.0	68	6	5	2.0	67	6	7	9.0
23	104	6	11	3.5	79	8	5	2.0	62	12	3	2.0	60	10	10	10.0

* = Less than 15 days/month for F_a or less than 7 days/month for V_d

F_{am} = Median value of effective antenna noise in dB above ktb

D_u = Ratio of upper decile to median in dB

D_l = Ratio of median to lower decile in dB

V_{dm} = Median deviation of average voltage in dB below mean power

Table A-2

THREE-MONTH TIME-BLOCK VALUES OF RATIO NOISE

Station: LAEM CHABANG Lat. 13.05°N Long. 100.9°E Period March-April-May 1967

FREQUENCY (MHz)	TIME BLOCKS (LST)																							
	0000-0400				0400-0800				0800-1200				1200-1600				1600-2000				2000-2400			
	F_{am}	D_u	D_l	V_{dm}	F_{am}	D_u	D_l	V_{dm}	F_{am}	D_u	D_l	V_{dm}	F_{am}	D_u	D_l	V_{dm}	F_{am}	D_u	D_l	V_{dm}	F_{am}	D_u	D_l	V_{dm}
0.53	100	7	11	4.0	93	13	11	3.5	86	16	14	5.0	97	11	19	6.0	101	8	12	4.0	102	5	10	3.0
2.3	76	9	6	3.0	73	11	8	4.0	63	10	8	4.0	69	9	12	4.0	77	8	8	2.0	79	7	6	2.0
5	63	11	8	1.5	59	8	8	2.0	46	8	5	3.0	47	9	7	3.0	64	6	7	1.0	69	8	7	1.0
10	55	9	6	6.0	55	9	8	5.0	39	10	7	7.0	41	9	7	6.0	59	7	8	5.0	63	7	7	5.0

F_{am} = Median value of effective antenna noise in dB above ktb

D_u = Ratio of upper decile to median in dB

D_l = Ratio of median to lower decile in dB

V_{dm} = Median deviation of average voltage in dB below mean power

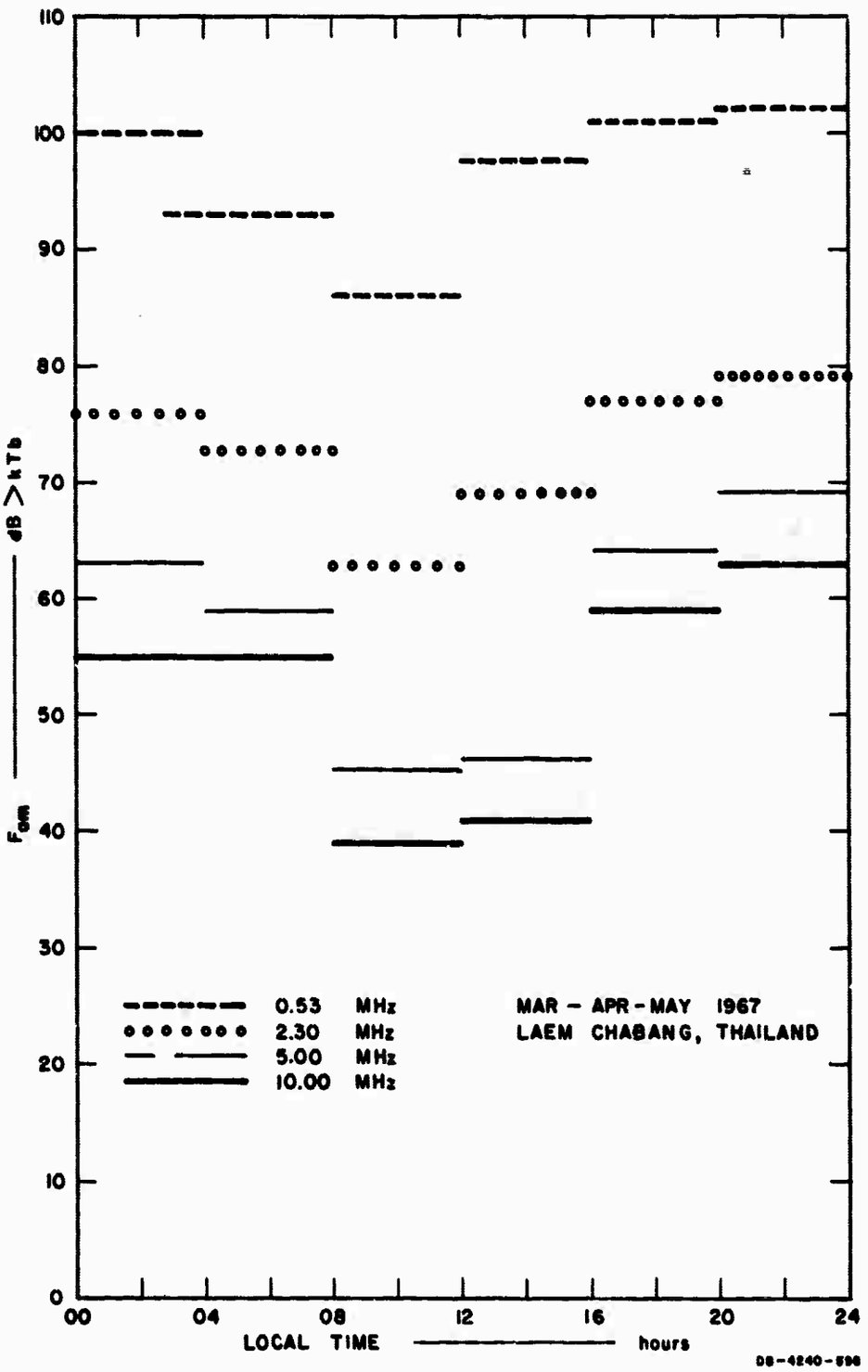

FIG. A-1 THREE-MONTH MEDIAN TIME-BLOCK VALUES OF RADIO NOISE POWER

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14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Radio Noise						
Atmospheric Noise						
Radio Noise Recorder						
ARN-3						
VLF, LF, MF, HF						
Thailand						
SEACORE						